REMARKS

Applicants and their undersigned attorney have carefully reviewed the first Office Action of June 9, 2003 in the above-identified patent application, together with the prior art references cited and relied on by the Examiner in the rejections of the claims. While the prior art references are related to the photonic packaging field and use much of the same technical vocabulary, specific differences in technology exist between the present invention and the prior art references. The present invention is not anticipated by, and is not obvious in light of, the prior art. In response, the claims of the application have been amended to more clearly define the subject invention over the prior art cited and relied on by the Examiner. Reexamination and reconsideration of the application, and allowance of the claims is respectfully requested.

The subject application discloses and claims a process for aligning an optical fiber with a photodetector surface in a housing during fabrication of a photonics package. The package includes of a hermetically sealed housing having a rear wall, a front wall, a top wall, a bottom wall and two sidewalls. The front wall has an aperture closed by a first lid, and the first lid includes a second aperture. The top wall also includes a viewing window that is closed by a second lid. The package further includes photodiode and radio frequency (RF) circuitry in the form of a single monolithic millimeter integrated circuit (MMIC). A jacketed optical fiber, which supplies optical signals to the photodiode, is sealed in a ferrule with an end of the fiber extending beyond the ferrule. The ferrule, in turn, is sealed in a coaxial flange, and the ends of the ferrule and optical fiber are inserted into the second aperture. The flange is sealed to the exterior surface of the first lid around the second aperture.

Fabrication of the package is completed by first mounting the MMIC to the interior of the housing, specifically on the interior surface of the rear wall. The housing walls and the first lid

are hermetically sealed. The optical fiber is sealed in the ferrule with a free end of the fiber extending beyond the ferrule. The ferrule is inserted into the flange to form an optical fiber assembly. The assembly is positioned in the second aperture. An automated system, using the viewing aperture in the top wall, aligns the free end of the fiber with the photodetector surface. Once aligned, the ferrule and flange are sealed. The flange is secured to exterior of the first lid by a relatively slow-setting sealant, such as solder. The slow-setting sealant allows the automated system to realign the fiber, as needed. Finally, the viewing aperture is sealed by the second lid. It should also be noted that the MMIC photodetector chip may also include other circuitry. For example, it may incorporate a RF amplifier having its input connected to the photodetector and having its output connected through the rear wall to a high frequency connector, in a conventional manner.

In the Office Action of June 9, 2003, the Examiner objected to the title of the invention as well as informalities at page 5, line 17 (paragraph 0014) and page 7, line 18 (paragraph 0019). The Examiner's objections are well-taken and appreciated. The title and paragraphs 0014 and 0019 have been amended as requested.

The Examiner rejected the claims under 35 U.S.C. 103(a) as being unpatentable over Boger et al. or Falkenstein et al. and rejected the claims under 35 U.S.C. 102(e) as being anticipated by Wang et al. First, claims 1-17 were rejected under 35 U.S.C. 103(a) as being unpatentable over Boger et al. Boger describes a specific photonic package that employs the use of a bulkhead optical connector (see Field of the Invention). The package includes numerous mechanical components held together by spot welding. Not only is this very expensive, unreliable, and difficult to automate, but the applicant further contends that the photonic device of the Boger reference can only be limited to those devices that are side-emitting or side-collecting. The photonic device is mounted in the same plane as the other electrical components,

with the fiber axis also along this same plane. Therefore, the fiber adjustment window is not located *opposite* the photosensitive element, as is required by applicant's claim 14. While the device could be placed on the back wall, as the Examiner contends, it would require extraordinary means in placing and assembling the device manually that would not be obvious, efficient or cost-effective. Performance of the photonics package would be degraded as the device would be electrically interconnected to the connector or other RF component with a 90-degree connection.

In contrast, the invention of the subject application employs a novel technique of aligning a fiber perpendicularly to a surface collecting or surface-emitting photonic device, thus allowing the photonic device and electrical components to exist on the same plane. This planarized technique, as opposed to a 90-degree electrical connection via ribbon bond, epoxy, circuitry metallization, or the like, minimizes the loss of the critical electrical connections from the photonic device to the output RF connector, increasing package performance, producibility, and repeatability of the package assembly. This is particularly crucial for high bandwidth (>10 Ghz) and high data rate (>10 Gbps) devices. The entire process of the present invention can be automated since the package can remain in the same position with the cavity pointing upwards, and all of the components can then be attached. First all electrical components are placed within the cavity, the lid is welded over the components, and the fiber is aligned through a hole in the lid and secured in place. The Boger reference does not teach a fully automated system, and the applicant contends that the Boger process could not be fully automated. The Boger package is specifically side-emitting or side-collecting and can not be read onto the present invention.

The present invention includes additional features that distinguish it from the Boger reference. For instance, it uses fewer components than the Boger reference for aligning and securing the fiber. Importantly, a slow-setting or slow-curing sealing material allows the flange,

and thus the fiber, to be repositioned while the flange is sealed to the housing. On the other hand, the Boger patent requires, in two distinct steps. Namely, the flange is first aligned and then the flange is welded to the housing "[w]hen the fiber 20 is aligned to the device 12 in the X- and Y-direction." (Col. 3, Line 62) The subject application even notes, "[i]t has been found that welding the clamp can cause movement of the fiber, however, resulting in optical misalignment of the photodetector and the fiber. When this occurs, it is difficult to realign the fiber with the photodetector, and a permanent loss of signal through the optical package can result." (Paragraph 0004) In fact, the Boger reference goes so far as to specifically teach additional welds to a mounting ring to fine tune the alignment for sub-micron accuracy. Therefore, welding the flange in the manner described in Bolger is a distinct disadvantage that is solved in a novel manner by the present invention. An individual skilled in the area of photonic packaging would recognize that there are unobvious technological differences between the Boger reference and the present invention.

The claims have been amended to more clearly distinguish these differences over the prior art. Applicant requests that the claims be amended in order to clarify the scope of the claims. Reconsideration and allowance of the claims over Boger is respectfully requested.

The Office Action next rejected claims 1-14, 15 and 17 as being anticipated by Wang et al. The Wang reference describes a coupling technique for securing an optical fiber into an entirely different type of package than that of the subject application. An individual skilled in the area of photonic packaging would appreciate that the Wang package is a plastic TO package using a heat-cured epoxy. TO package housings resemble cylindrical cans containing a semiconductor component. The TO package described in Wang appears to be non-hermetic, non-complex, and limited to low bandwidth and low data rate devices. The "perfect alignment" of such a package is not equivalent to the sub-micron alignment tolerances of the present

invention.

Notwithstanding the fact that the type of package is different, the assembly of the Wang package is described by the following step:

> "*After* adjusting the support member and the receptacle to have the light source and the optical fiber in perfect alignment, a heat cured epoxy is applied between the first and second junction surfaces, power is then supplied to the resistance wire to heat and cure the heat cured epoxy and thus securing the receptacle 28 to the support member 14..." (Col. 3, Line 31. Emphasis added).

Thus, the Wang patent does not allow the fiber to be aligned while the epoxy sets, unlike the solder of the present invention. Apparently, the junction surfaces are disconnected *after* aligning the fiber in order to apply the epoxy. This would obviously be detrimental to the alignment accuracy of the fiber and photodetector. In addition, the heating process provides additional complexities that may alter the alignment of the fiber. In comparison, the present invention uses a preheated solder that allows the optical fiber assembly to be realigned *as* the solder cools. The Wang patent also does not disclose, and does not anticipate, a fully automated assembly process wherein a viewing aperture is used by the system to align the fiber and photodetector.

Limitations have been added to the claims of the subject application in order to clearly distinguish these differences over Wang. Applicant requests that the claims be amended in order to clarify the scope of the claims. Reconsideration and allowance of the claims over Wang is respectfully requested.

Finally, the Office Action rejected claims 1-17 as being unpatentable over Falkenstein et al. under U.S.C. 103(a). However, the Falkenstein reference is outdated and significantly different from the present invention. The summary of the invention states that a tolerance of plus or minus three μm in all three directions is acceptable whereas the present invention employs sub-micron tolerance as is needed for devices with operating frequencies in the 10 Ghz range and

beyond. Falkenstein also discloses the use of flux solder that is almost entirely avoided in current photonic packaging.

The Examiner states that Falkenstein teaches, at col. 6, lines 27-38, a flange, or adjustment member, T *adjustably* secured to a front wall by solder. However, the cited language does not teach that the flange is adjustably secured. Once the tube R is fastened to the adjustment member T and the adjustment member T is fastened to the housing G/K, "the position of the glass fiber tip S is ultimately *fixed* by the stiff tube R..." (Col. 6, Lines 31, 32). This directly contravenes the slow-setting solder of the present invention that provides for adjustment of the fiber while the solder affixes the flange to the housing.

Falkenstein also states at Col. 2, Line 53 that the glass fiber bushing of the invention does not provide "a hermetic gas tightness or air tightness in every instance..." The present invention is specifically and entirely hermetically sealed. The Falkenstein reference also focuses on the use of an elastic cover for the fiber adjustment window while the present invention uses a solid lid. The Falkenstein patent does not disclose a secondary window or an automated assembly system. In fact, assembly of the Falkenstein package appears to be a two-step assembly since it is first necessary to attach the photonic device and any other discrete component to clip B, which would then be placed into housing G.

The claims have been amended to more clearly distinguish these differences over the prior art. Applicant requests that the claims be amended in order to clarify the scope of the claims. Reconsideration and allowance of the claims over Falkenstein is respectfully requested.

The references discussed above do not show or suggest the structure of the subject invention. There is no teaching or suggestion of a setting solder material that allows an optical fiber to be adjusted while a flange housing the fiber is sealed to a photonics package. There is no teaching or suggestion of a viewing window allowing for precise alignment of a optical fiber and

photodetector. All of the claims now pending in the application are believed to be patentable.

Claims 1, 6, 9, 10, 13, 14 and 16 have been amended. Notably, claim 1 has been amended to clarify that the process includes *affixing* the flange to the housing as opposed to welding the flange. Claim 1 now also includes the process of adjusting the position of the flange on the housing *while* the solder seals the flange to the housing. Amended claim 13 includes the amendments of claim 1 as well as the planarizing technique of the present invention. Claim 14 is amended to include the planarizing structure of the present invention wherein the axis of the optical fiber lies in a plane perpendicular to the plane of the photosensitive element. Among other amendments, claim 14 also includes the limitation of a viewing aperture. Claims 2-4, 7, 8, 15 and 17 have now been canceled. Claims 18-21 have been added. It is believed that the claims now pending are patentable over the prior art cited and relied upon by the Examiner. In view of the foregoing, reconsideration and re-examination of the application, allowance of the claims, and the passage of the application to issue is respectfully requested.

Respectfully submitted,

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